

# Research Progress of Creatine Sports Nutrition Supplements on Improving the Physical Fitness of Athletes

Xinyu Wu

International Education College, Zhengzhou University of Light Industry, Zhengzhou, 450002, China  
eeric91470@gmail.com

## ABSTRACT

With the development of sports nutrition, creatine, as a sports nutrition supplement, has shown remarkable effects in improving sports performance, strengthening muscle strength and endurance. In this paper, creatine's physiological effects and the mechanism of use, side effects and safety studies, the impact on sports performance, the application in athletes and the collocation of daily nutrition intake were reviewed. Studies have shown that creatine supplements improve athletes' performance in short bursts of high-intensity exercise by increasing creatine phosphate storage in muscles. Although creatine supplements are considered safe in most cases, further research is needed on the effects of side effects and dosages. Future research is needed to explore the optimal use of creatine, its use in specific populations, and its combination and intake with other nutrients.

## KEYWORDS

Creatine supplement; Sports performance; Safety; And nutritional mix

## 1. INTRODUCTION

For fitness enthusiasts or fitness athletes, regular dietary intake can not meet their needs for some nutrients. Therefore, sports nutrition supplements can very meet the needs of these people, and can be targeted to supplement one or more specified nutrients (protein, vitamins, etc.), which is easier to absorb, more convenient and more cost-effective [1]. The Australian Institute of Sport (AIS,) notes on sports nutrition supplements that sports foods and supplements can play a small but important role in the sports nutrition program of high-level athletes. AIS classifies sports supplements into four categories: A, B, C and D, of which category A is clearly shown to improve athletic performance by existing evidence. Creatine is one of the category A sports nutrition supplements. The purpose of this study is to review the structure, function and mechanism of creatine to improve the physical condition of human body, and provide theoretical support for the future research and development of sports supplements.

## 2. CREATINE'S PHYSIOLOGICAL FUNCTION AND USE MECHANISM

Creatine is synthesized from arginine, glycine and methionine. It is a naturally occurring nitrogenous compound. It can combine with inorganic phosphorus (Pi) in cells to form creatine phosphate (PCr), which can be used as high-energy phosphate energy to synthesize adenosine triphosphate (ATP), which has been degraded into adenosine diphosphate (ADP). And as an energy source to promote cell metabolism [2]. Creatine in the human body is divided into endogenous creatine and exogenous creatine, which is widely distributed in various organs of the human body, of which the highest content is about 95% in skeletal muscle, and a small amount exists in brain and testis (5%) [3].

Creatine content has no significant correlation with age and gender [4]. Creatine is a non-essential food compound found mainly in meat, fish and other animal products [5]. It is estimated that these dietary sources typically contribute to an intake of about 1-2 grams of creatine per day, with vegetarians having lower total creatine levels compared to non-vegetarians [5]. The end product of creatine metabolism is creatinine, which is released from the blood and filtered through the kidneys before being excreted in the urine [6].

The main function of creatine is to replenish various organs of the human body, such as skeletal muscle, cardiac muscle, smooth muscle, eye, brain, nervous system, etc. [7]. Increased intracellular creatine levels can improve its performance in sports. Excess creatine in the muscle does not increase the concentration of ATP in the muscle at rest, but sufficient creatine can promote the resynthesis of ATP and creatine phosphate consumed during exercise, thereby maintaining the concentration of ATP in the muscle during repeated maximum training [8]. This minimizes the production of local muscle lactic acid, allowing the body to exercise at a higher intensity for a longer period of time. Helps the body build strength, increase the ability to do work, build muscle and prevent premature fatigue. Studies have shown that surface creatine can effectively reduce the symptoms of osteoporosis in the elderly [9]. In the normal development of bone, cell survival, proliferation, differentiation and extracellular matrix synthesis are essential processes. In these processes, ATP plays an indispensable role. ATP plays the role of production, storage and utilization through the creatine system. Therefore, creatine plays an important role in the growth and development of bones. In addition, creatine also plays a key role in transferring energy-related intermediates from the electron transport system of mitochondria into the cytoplasm.

At present, creatine nutrients are mainly classified into the following categories [10-12]. As shown in Table 1 below:

**Table 1.** Creatine nutrient types [13]

Creatine nutrition type	Ingredients	Strengths	Weaknesses
Classic creatine	Creatine monohydrate	Cheap	Long impact period, low absorption and low solubility
Creatine Compounds	Creatine hydrochloride, creatine citrate, creatine phosphate, creatine compounds	Small dosage, high solubility and high absorption	High price
Compound creatine	Pure creatine + glucose+ novel nutrient fortification Agent (calcium pyruvate and phosphate)	High absorption rate	High price and high dosage
Cells esterify creatine	Creatine+ insulin stimulating factor	High absorption rate	High price and high dosage

At present, creatine monohydrate is the most widely used in the market because of its high purity and high sexual value [14]. The intake of creatine monohydrate should be strictly controlled. The International Society of Sports Nutrition recommends that 3-5 grams of creatine monohydrate be taken daily for the best effect, while high doses of creatine that exceed the body's absorption capacity have a weak effect [15].

### **3. SIDE EFFECTS AND SAFETY STUDIES OF CREATINE SUPPLEMENTS**

The European Food Safety Authority (EFSA) has evaluated various health claims regarding creatine and bodily function/ability or memory function. Health claims regarding creatine and improving physical function during short, high-intensity, repetitive exercise have been authorized by the European Commission. In addition, several established international sporting bodies, such as the Australian Institute of Sport (which lists creatine as A Class A supplement) or the American College of Sports Medicine, have classified creatine as an evidence-based performance-enhancing dietary supplement [16]. Studies have shown that when used appropriately (up to 30g/ day), both short - and long-term supplementation (trials lasting 5 years) is safe and well tolerated in healthy individuals [17, 18]. When creatine is supplemented to a saturated state, the creatine content will return to the baseline level after 4 to 6 weeks of normal discontinuation, and then will stop declining, so it can be assumed that long-term creatine supplementation will not inhibit endogenous creatine synthesis and the body will not become dependent [17].

### **4. THE EFFECT OF CREATINE SUPPLEMENTATION ON ATHLETIC PERFORMANCE**

Creatine exists in large quantities in the human body itself, under the premise of correct and appropriate use, mainly by increasing creatine phosphate (PCr) storage in muscles, can effectively improve people's performance in sports, and promote aerobic and anaerobic exercise ability. This increased PCr storage can provide more quickly available energy to the muscles, which is especially important for high-intensity exercise for short periods of time.

In terms of strength and explosive training, creatine supplements help athletes maintain a high level of performance during repeated high-intensity exercises by increasing the rate of ATP resynthesis. Multiple studies have shown that athletes who take creatine during weight training demonstrate higher total strength output and better resistance to fatigue. In addition, creatine supplements have also been associated with muscle growth and thickening of muscle fibers, which is especially beneficial for strength athletes.

And in the context of endurance sports, while creatine is often associated with high-intensity, short periods of exercise, research in recent years has also begun to reveal its potential benefits for endurance performance. The positive effects of creatine supplements on endurance exercise may come from their optimization of the muscle recovery process, as well as their potential increased effects on glycogen storage. This means that athletes may experience a faster recovery process after several consecutive days of intense training and thus be able to return to a high level of training more quickly [19].

It is important to note that the effects of creatine supplements vary from individual to individual, which may be influenced by genetic factors, muscle fiber type, dietary habits, and prior training status. Therefore, although numerous studies have shown a generally positive effect of creatine supplementation on athletic performance, its specific application still needs to be considered on an individual basis.

In summary, creatine supplements play an important role in enhancing athletic performance, and creatine has shown its unique benefits both in strength and explosive training and in endurance sports. These findings not only have guiding significance for athletes and coaches in the formulation of strategies in training and competition, but also provide an important scientific basis for the development of sports nutrition products.

## **5. THE APPLICATION OF CREATINE SUPPLEMENT IN ATHLETE POPULATION**

The use of creatine supplements has received particular attention among adolescent athletes. Studies have shown that adolescents often show positive athletic performance improvements when using creatine supplements, such as improved performance in strength and short bursts of high-intensity exercise. However, because the adolescent body is still developing, there is insufficient research on the effects of long-term creatine supplement use on growth and development [20].

For adult athletes, creatine supplements have been shown to be effective in improving athletic performance, especially in sports that require short bursts of power. The use of creatine appears to be more common and its effects more pronounced among adult male athletes. In contrast, for female athletes, although creatine can also improve their athletic performance, women's response to creatine may be somewhat different from that of men due to physiological differences.

Creatine supplements have also been shown to have a positive effect on older athletes or people with certain health conditions, such as those with degenerative muscle diseases. For older adults, the use of creatine may help improve muscle function and overall vitality, thereby improving their quality of life. In some specific health conditions, such as muscular dystrophy, creatine supplements may be used as an adjunct treatment to help improve muscle function.

While creatine supplements have shown positive effects in different groups, more research is needed to explore individual differences and the long-term effects of specific conditions. Therefore, the use of creatine supplements should be considered for individual circumstances and is best done under professional guidance.

## **6. THE COMBINATION OF CREATINE AND DAILY NUTRIENT INTAKE**

First, carbohydrate intake stimulates the secretion of insulin, which acts as a powerful absorption enhancer, helping creatine to be absorbed more efficiently by muscle cells. Studies have shown that taking creatine with simple sugars increases the amount of it stored in muscle. Therefore, adding an appropriate amount of high-glycemic index carbohydrates, such as glucose or maltose, is an effective strategy when taking creatine supplements. Secondly, protein intake is also crucial for the effectiveness of creatine supplements. Not only is protein the foundation for muscle growth and repair, it also works synergistically with creatine to increase muscle strength and size. Given that both creatine and protein are key factors in muscle synthesis, using them in combination, especially after training, can optimize the recovery and adaptation process. Some micronutrients, such as magnesium and zinc, are also associated with the effects of creatine supplements. They are an important component of many enzymes that help maintain normal muscle and nerve function and may affect the efficacy of creatine [2, 21, 22].

## **7. FUTURE RESEARCH DIRECTIONS AND CONCLUSIONS**

Although creatine is considered safe, the effects and potential risks of long-term use need further study. Especially for cases of high doses and long-term use of creatine, it is critical to understand the long-term effects on the body. Future research should also explore novel formulations and ingestion of creatine supplements to improve their absorption and utilization in the body [23-26].

Creatine has shown great potential as a sports nutrition supplement to enhance athletic performance and promote muscle health. Future research is needed to continue to explore the optimal use of creatine, its use in specific populations, and its interactions with other nutrients to more fully understand and utilize this powerful sports nutrition tool.

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